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ON THE CORRELATION OF RADAR ECHOES OVER FLORIDA
WITH VARIOUS METEOROLOGICAL PARAMETERS

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1. Introduction

One of the more difficult forecast problems in Florida is summertime showers. Drastic changes often occur in the shower regime despite persistence of the major map features. Conditionally unstable air prevails during the summer season and small deviations in either the dynamics or thermodynamics of the atmosphere can produce rather dramatic changes in the convection. These deviations are extremely difficult to foresee. Gentry (1950) revealed the nonpersistent character of showers in the vicinity of Miami. Using 10 rain gauges, he recorded the number receiving rain each day. During five summers, there were almost equal numbers of days in which no stations reported rain, one station reported rain, two stations reported rain, etc. up to ten stations reporting rain. In other words, the shower regime is quite variable.

A number of people have investigated this problem with only limited success. Carson (1954) gives a very complete survey of many published as well as unpublished reports. All of these studies were based on rain gauge reports and, therefore, suffer from limitation imposed by the network of recorders. There was almost unanimous agreement that low level moisture was a most important parameter.

During the summers of 1963 and 1964 a rather unique set of data was collected which offers a vast improvement over the rainfall records and lends itself nicely to the Florida shower problem. Radar echoes were manually recorded on a 7.5 by 7.5 mile grid every three hours at Miami, Daytona Beach, and Tampa. The radar sets were all placed on 100 mile range. The areal coverage as well as the grid is shown in figure 1. From this data one can accurately obtain the percentage of the peninsula covered by radar echoes at each observing time. All echoes are assumed to be showers. Considering the geographical location and time of the year, this is probably reasonable.

In an attempt to discover conditions which are favorable for showers, the echo areal coverage was correlated with a number of meteorological parameters which could be extracted from radiosonde observations. The parameters used are listed in table 1. In all cases except divergence, vorticity, and vertical motion, they represent averages from the three radiosonde stations at Jacksonville, Tampa, and Miami. The correlations are between data taken from the morning sounding (1200Z) with afternoon echoes at 1300, 1600, and 1900 LST. Myers (1964) did a similar computation for central Pennsylvania.

The Bellamy triangle method (1949) was used in computing divergence, vorticity, and the 500 mb vertical motion. Jacksonville, Tampa, and Miami form the apexes of the triangle. Day (1953) and Byers and Rodebush (1948) both computed the "Bellamy" divergence over Florida. Byers and Rodebush

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used this to support the hypothesis that the Florida thunderstorm maximum is due to a double seabreeze. Day found that "wet" days tended to be associated with stronger low level convergence. However, divergence calculated this way is very sensitive and seriously affected by small errors making it difficult to use in a day to day scheme.

2. Results

A survey of table 1 reveals the following points:

(A) The only significant correlations involve moisture. Poor correlations are obtained with the surface and 950 mb humidity because moisture is nearly always present at this level. The humidity correlations improve rapidly with height reaching a maximum at 650 mb. This means that showers are more likely with a deep moist layer! Chalker (1949) concluded the same thing in his study of air mass showers. This also supports the results of several studies cited by Carson.

(B) Even though the magnitude of the other coefficients are generally near or below the significant level, the sign often agrees with what we would expect. The following might be noted:

Showers at 1300 and 1600 tend to be associated with warmer surface temperatures and cooler temperatures above 850 mb. This is also supported by the 24 hour 500 mb temperature change and the 850-500 mb lapse rate.

Showers are more likely with cyclonic vorticity aloft.

Showers are directly related to surface convergence.

Even though the poorest correlations involve the heights, showers are more likely with a 24 hour 500 mb height fall.

(C) The correlations tend to be much better with the 1300 and 1600 observations than the 1900. This is because showers are more prevalent at the earlier times. Table 2 presents the average echo coverage (%) at various times during the day for July and August of 1963 and 1964. The shower distribution reaches a maximum during the afternoon between 1300 and 1600 LST, then drops considerably by 1900 LST.

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Table 1. Linear correlation coefficients relating the percentage of the Florida peninsula covered by radar echoes at the times specified and various parameters taken from the morning (1200Z) radiosonde observations at Jacksonville, Tampa and Miami. Data used in this table was collected during May through August, 1963. Non-computed parameters are averages from the three soundings.

12Z Observations	PERCENT COVERAGE		
	13 EST	16 EST	19 EST
Surface Humidity	0.21	0.21	0.24
950 MB Humidity	0.40	0.38	0.18
850 MB Humidity	0.56	0.60	0.48
750 MB Humidity	0.60	0.54	0.37
650 MB Humidity	0.65	0.66	0.46
Precipitable Water	0.56	0.44	0.25
Surface Divergence	-0.17	-0.11	0.09
950 MB Divergence	-0.18	0.09	0.12
850 MB Divergence	-0.06	0.20	0.27
750 MB Divergence	-0.16	0.09	0.20
650 MB Divergence	-0.20	-0.03	0.08
550 MB Divergence	0.01	-0.06	0.06
500 MB Vertical Motion	-0.22	0.09	0.26
Surface Pressure	-0.11	-0.09	0.03
950 MB Height	-0.08	-0.09	-0.02
850 MB Height	-0.03	-0.04	0.01
750 MB Height	0.00	-0.04	-0.04
650 MB Height	0.00	-0.06	-0.07
550 MB Height	-0.02	-0.10	-0.14
24 Hr. 550 MB Height Change	-0.17	-0.22	-0.09
Surface Temperature	0.24	0.15	-0.02
950 MB Temperature	0.11	0.01	-0.13
850 MB Temperature	0.10	-0.01	-0.19
750 MB Temperature	0.07	-0.01	-0.16
650 MB Temperature	-0.09	-0.24	-0.29
550 MB Temperature	-0.07	-0.18	-0.25
24 Hr. 550 MB Temperature Change	-0.04	-0.04	-0.15
Lapse Rate (550 MB-850 MB)	-0.17	-0.17	-0.06
Surface Vorticity	-0.06	-0.04	-0.05
950 MB Vorticity	0.09	0.03	0.09
850 MB Vorticity	0.26	0.18	0.13
750 MB Vorticity	0.19	0.09	0.03
650 MB Vorticity	0.15	0.12	0.06
550 MB Vorticity	0.18	0.24	0.23

Table 2. Average percent of the Florida peninsula covered by radar echoes during the months of July and August, 1963 and 1964 for the times specified.

Hour (EST)	01	04	07	10	13	16	19	22
July	4.1	4.1	4.7	11.8	19.6	19.7	12.5	6.2
August	1.2	1.3	2.2	6.4	19.4	23.3	14.8	4.2
July and August	2.7	2.7	3.5	9.1	19.5	21.5	13.6	5.2

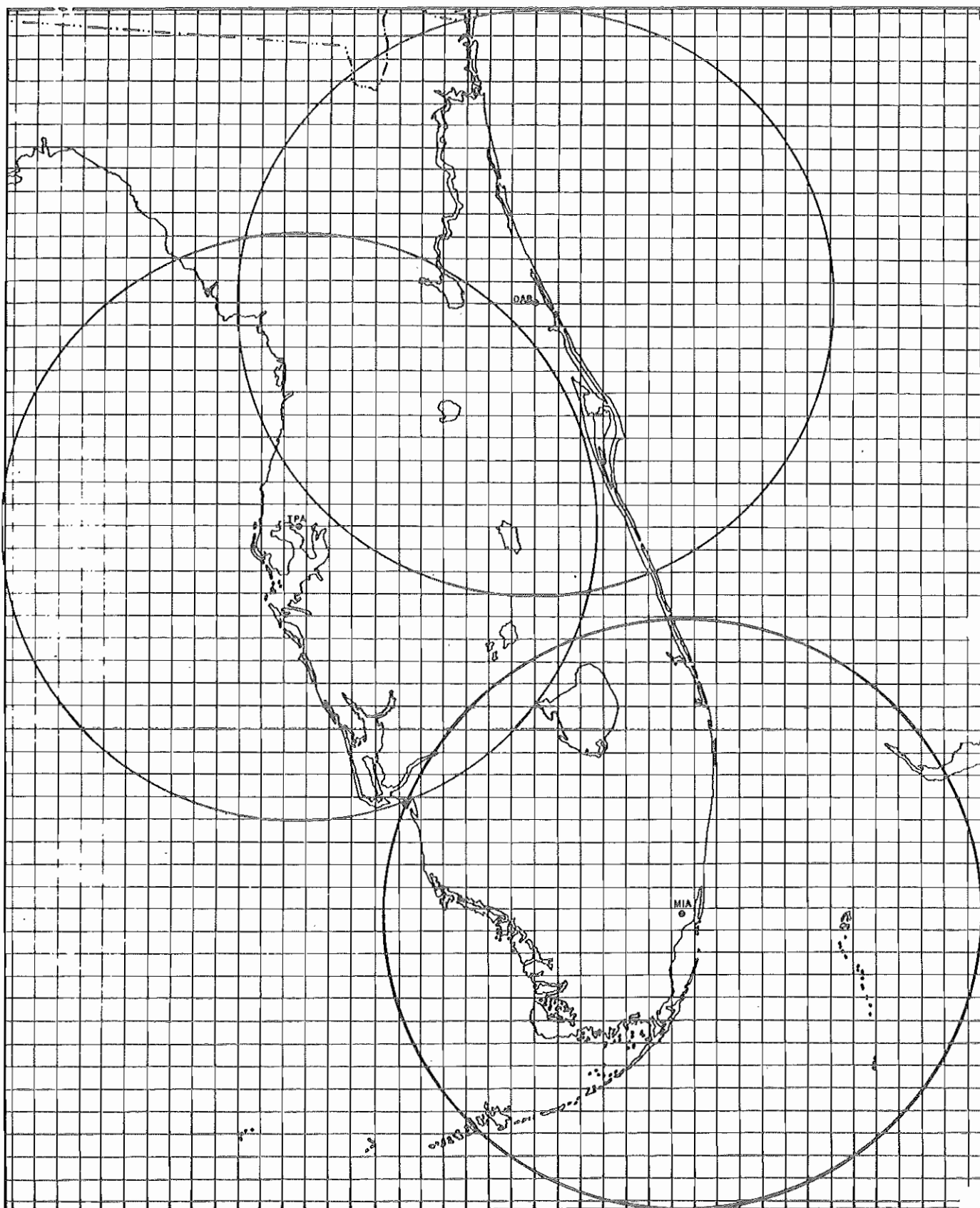


Figure 1. Radar range and Grid used to determine percentage of area covered by radar echoes.